Dark Matter Time Projection Chamber (DMTPC)

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DMTPC

DMTPC is a collaboration working to develop a directional detector using CCD readout to image scintillation light with CF_4 as a target medium.

We have developed three generations of of detector and have funding from NSF and MIT to build a 1 m^3 detector directional detector.

We operate our detectors in WIPP, near Carlsbad NM. We have operated out second generation 10L detector there for two years and are moving our third generation 20L detector to WIPP this Spring. There is ample space for our 1 m^3 detector.

The MIT group also develops detectors for directional neutron detection. This work is funded by MIT, Raytheon and the Institute for Solder Nanotechnology

Principle of Operation

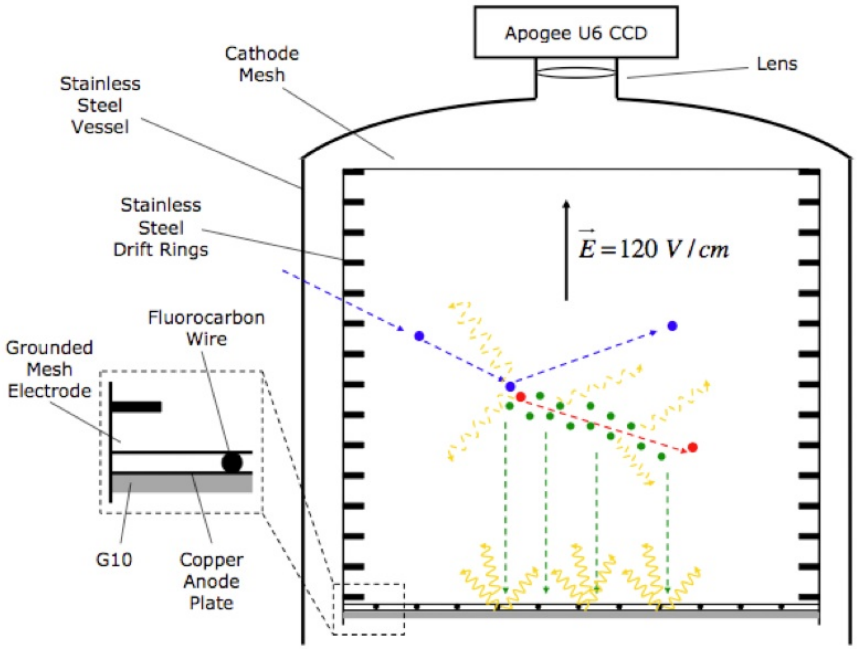
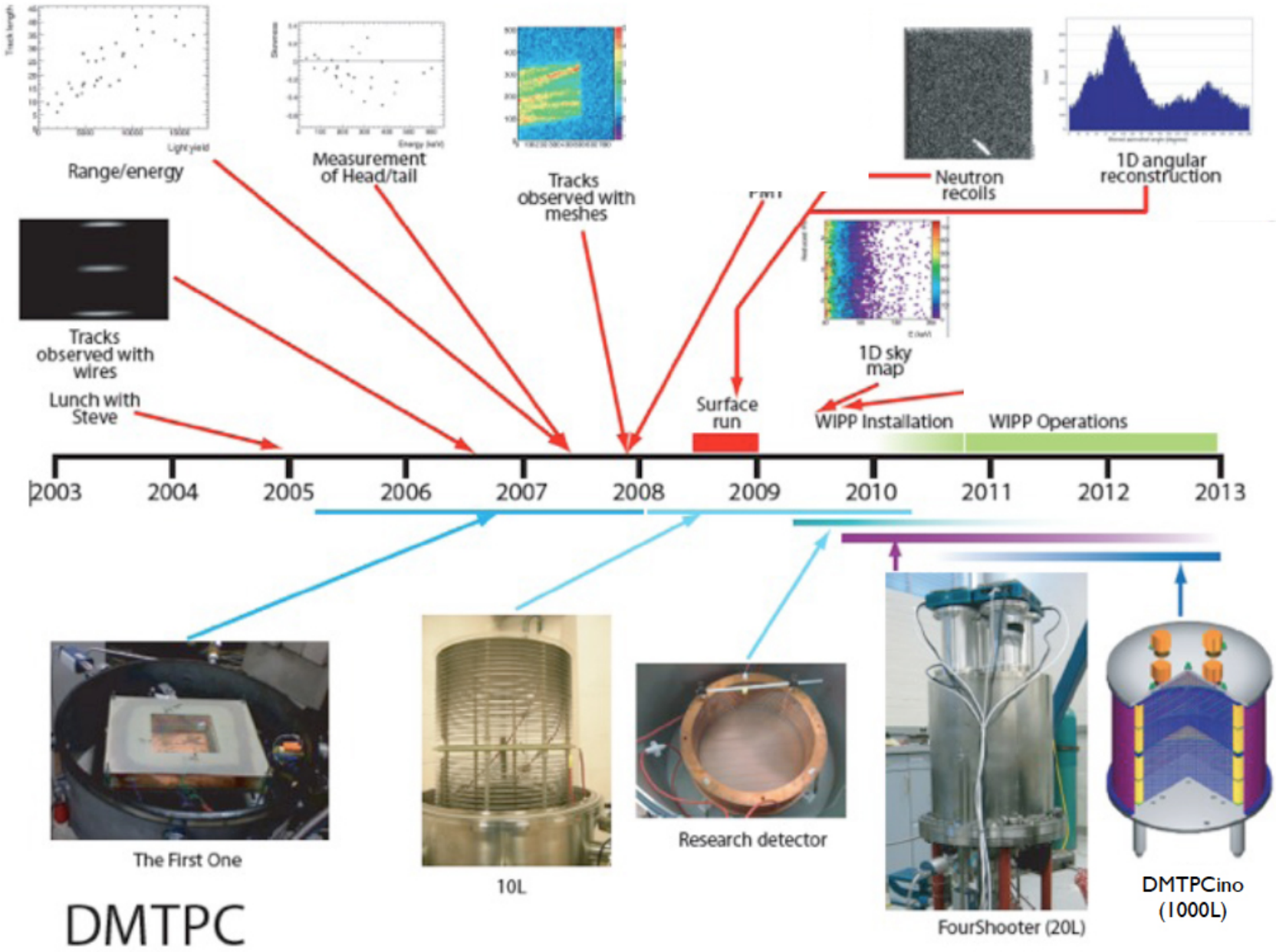
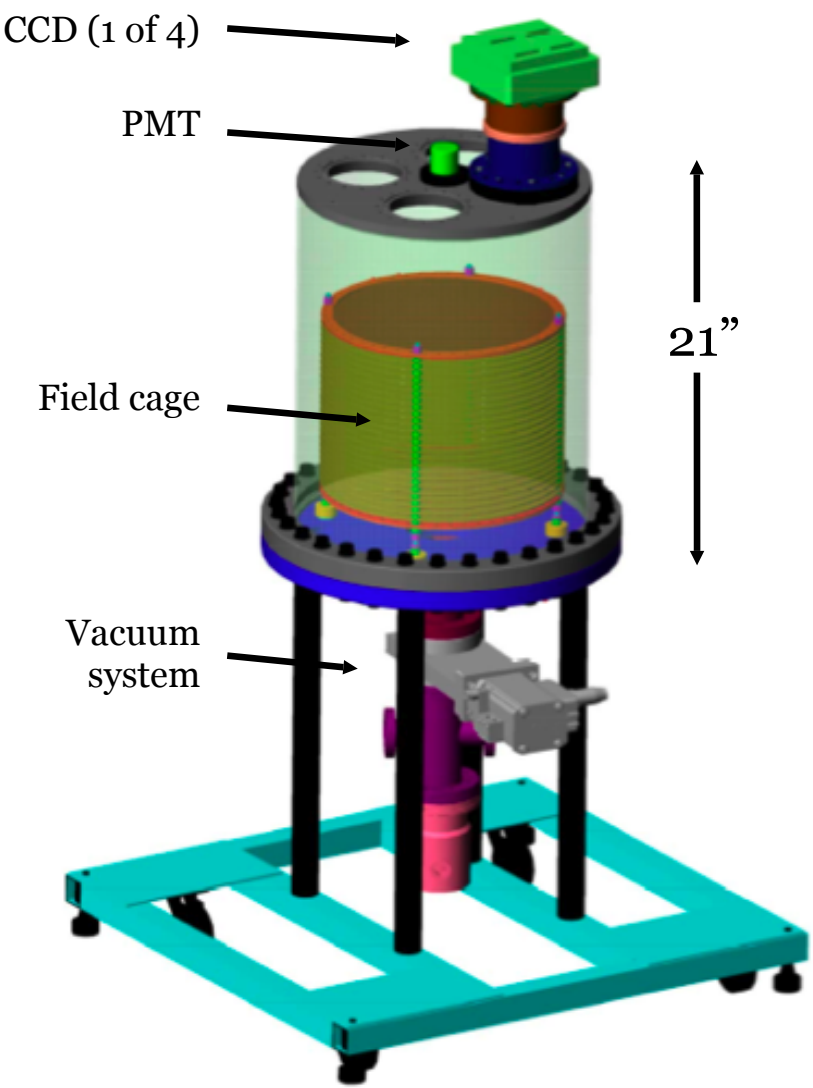


Figure: Schematic view of detector

- Incident neutron strike nucleus in dilute gas
- Nucleus recoils leaving ionization train in gas. More ionization at the start of the recoil.
- Electric field drifts ionization to amplification region
- Amplification of 10^5 generates light in pattern of ionization trail
- CCD camera images the light and record the direction of the recoil.


Range/energy
Measurement of Head/tail
Tracks observed with meshes
Neutron recoils
1D angular reconstruction
Tracks observed with wires
1D sky map
Lunch with Steve
Surface run
WIPP Installation
WIPP Operations
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
The First One
10L
Research detector
FourShooter (20L)
DMTPCino (1000L)
DMTPC

FourShooter



50L detector

Recoil event identification

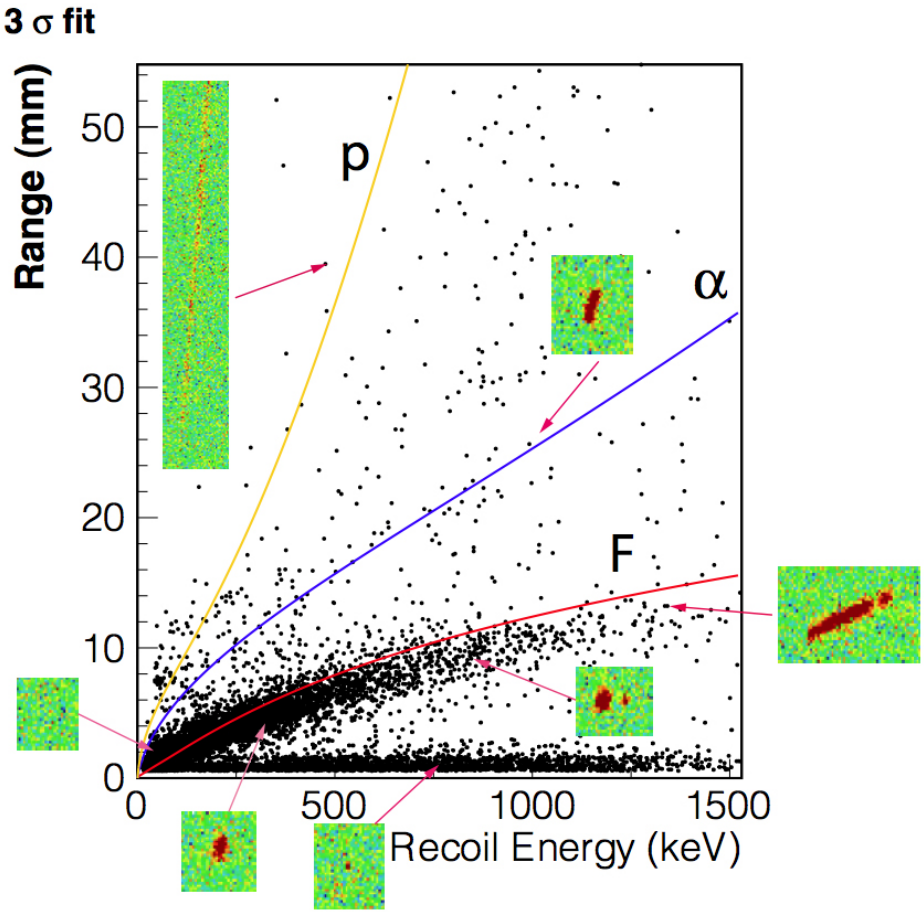


Figure: Data from 10L detector containing CF_4 only.

The relationship between range and energy is different for each kind of particle or background signal

- Allows rejection of sparks from amplification region
- Insensitive to γ rays
- Redundant energy measurement.

Directional sensitivity

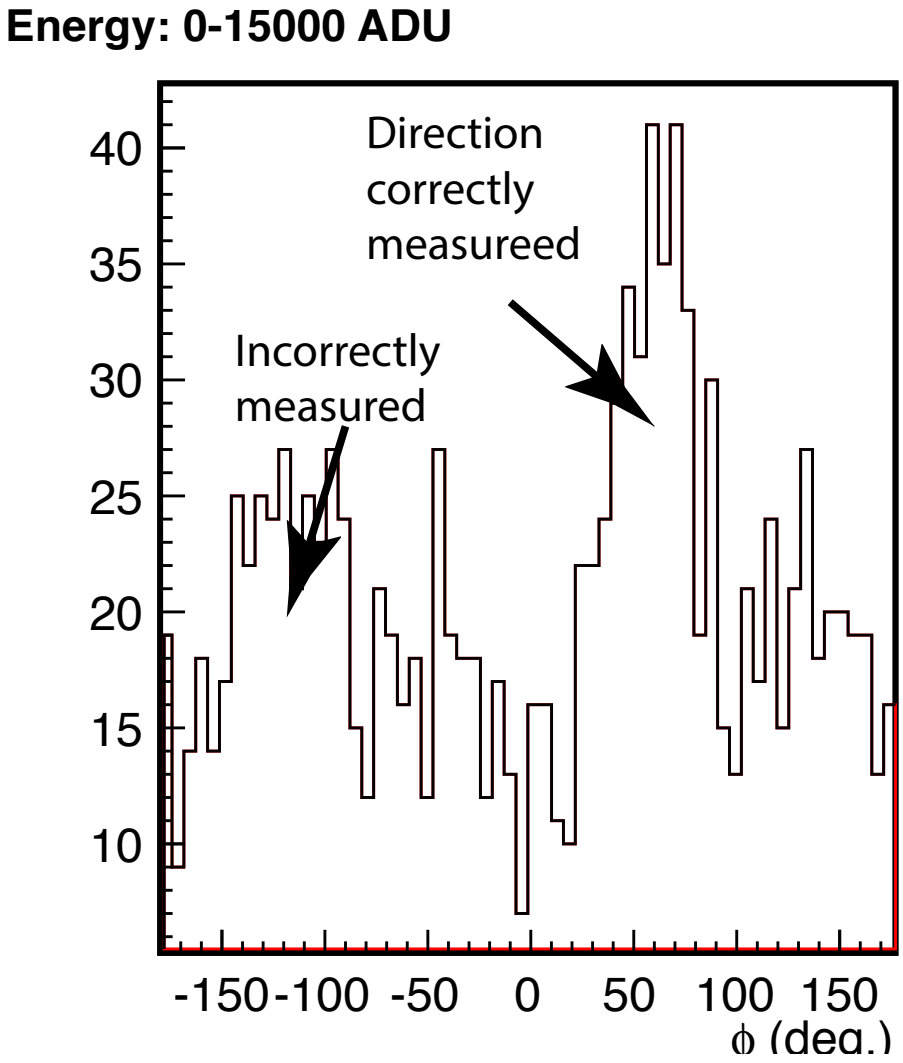


Figure: Directional from 50L detector containing CF_4 only.

Important Components

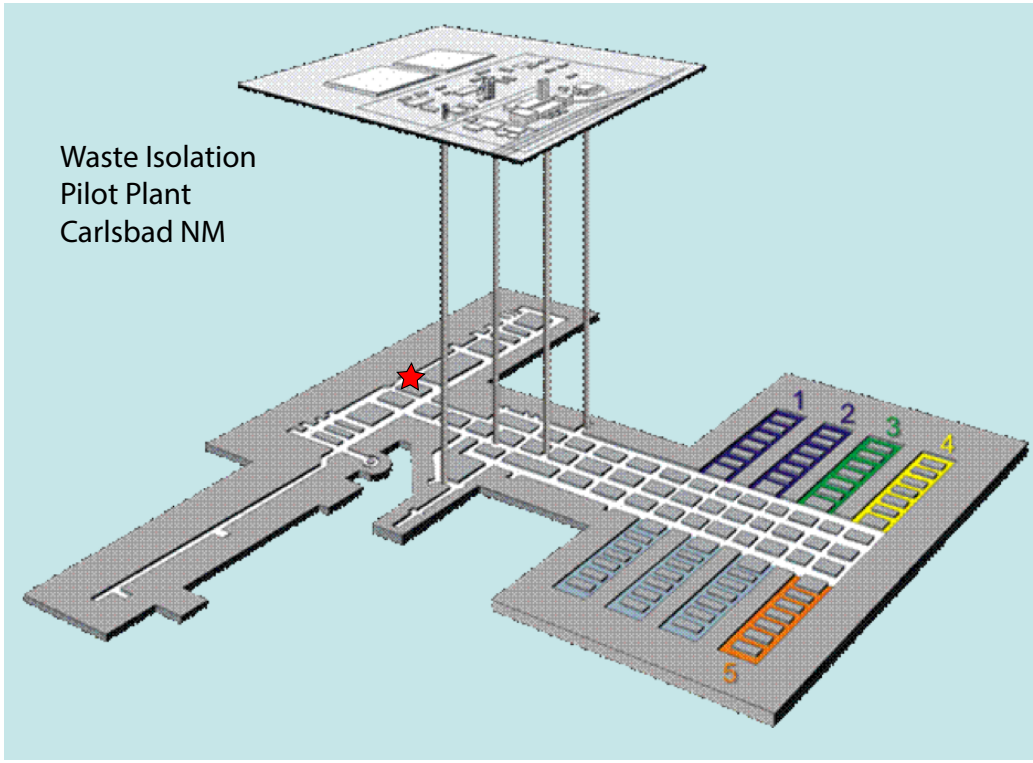
Camera

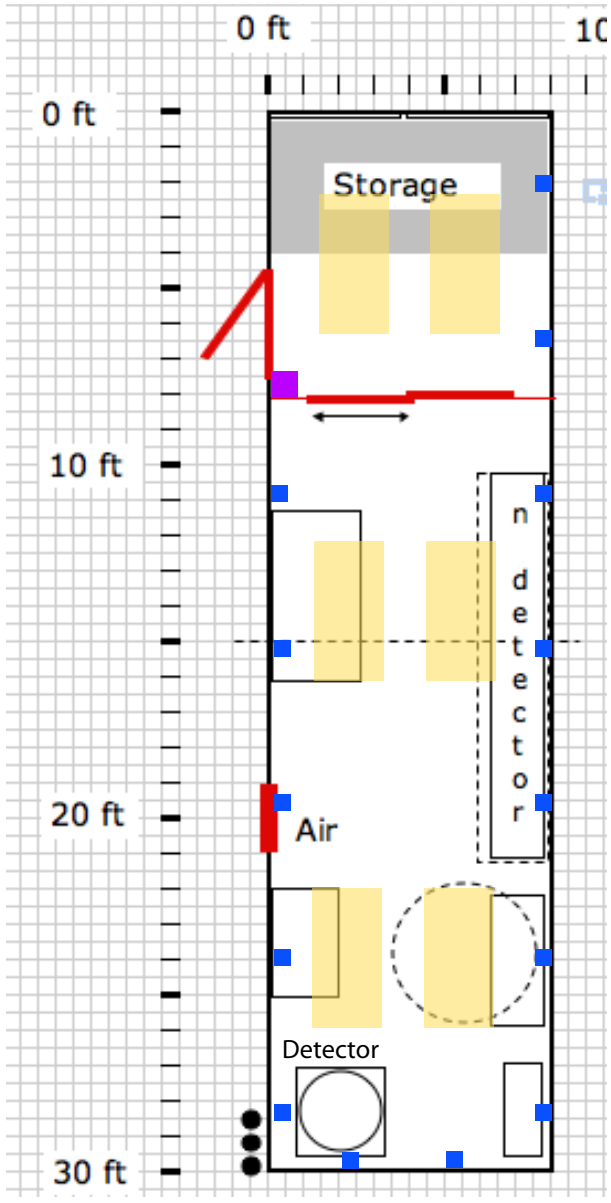
- Andor iXon EMCCD
- 1 electron read noise, highest sensitivity CCD
- Back illuminated-insensitive to sparks
- 1024 *times* 1024 pixels - 350 μ resolution

Schnieder Xenon Lens

- 25 mm focal length matches requirement for 50 cm drift without large standoff
- f/#=0.95 images entire active region
- Compact design

Underground site





Future plans

We are currently

- Writing up results from the 10L detector operation underground
- Preparing to move the FourShooter underground. It will operate there for at least a year
- Completing the design of the 1 m^3 detector

We plan to operate the 1 m^3 underground for at least at year. At that time, we will decide how to move forward based on the dark matter state of play. At this moment, we are not making plans beyond the 1 m^3 detector.